PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
B01D 39/08, A41D 13/00

A1

(11) International Publication Number: WO 98/53896

(43) International Publication Date: 3 December 1998 (03.12.98)

(21) International Application Number: PCT/US98/10159

(22) International Filing Date: 18 May 1998 (18.05.98)

(30) Priority Data:
08/866,490 30 May 1997 (30.05.97) US

(71) Applicant: KIMBERLY-CLARK WORLDWIDE, INC. [US/US]; 401 North Lake Street, Neenah, WI 54956 (US).

(72) Inventor: READER, Timothy, Wilson; 4850 Yorkshire Lane, Suwanee, GA 30024 (US).

(74) Agents: KLEMBUS, Nancy, M. et al.; Kimberly-Clark Worldwide, Inc., 401 North Lake Street, Neenah, WI 54956 (US).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: FACE MASK

(57) Abstract

The present invention is directed toward face masks wich are comfortable to wear while still having enhanced bacterial filtration efficiency and desirable breathability as evidenced below differential pressure values. The mask comprises: a layer of electret treated crimped conjugate fibers; and a wettable innermost layer adapted to adsorb water.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

FACE MASK

FIELD OF THE INVENTION

The field of the present invention is that of filtration devices such as face masks adapted to remove pathogens and particulates from a gaseous material, such as, for example, air while still being comfortable to wear.

BACKGROUND OF THE INVENTION

Since the discovery of pathogens such as bacteria and viruses and the advent of modern surgical methods, mankind has been seeking improved ways to protect pati nts and operating room personnel from the pathogens borne by each other and transmittable to each other by way of the air we breath. Examples of such airborne contaminates include, but are not limited to, biological contaminates, such as bacteria, viruses and fungal spores. Such contaminates may also include particulate material such as, lint, mineral fines, dust, skin squames and respiratory droplets.

One of the main weapons in this battle is the surgical face mask worn by op rating room personnel. This mask should allow the wearer to breathe easily whil , at th same time filtering out pathogens which may be in the air or in the wearer's breath. These two functions inherently contradict each other in that a perfect barrier, and thus p rfect protection, would be an impermeable material. Conversely, a material which is very easy to breathe through typically allows pathogens and particulates to pass asily th rethrough and fails in its filtration capacity. Accordingly, a balance must be struck between the two variables with, protection typically being paramount.

While not critical to its barrier function, it is highly desirable for a face mask to be comfortable to wear. In this regard, the more comfortable the face mask is, the more likely that it will be desired and used by operating room personnel. One problem which has confronted those of skill in the art is that, after a face mask has been worn for a p riod of time, perspiration will build up on the portion of the face of the wearer which the mask overlies making continued wearing undesirable from, at least, a comfort aspect.

In response to these obstacles, a variety of different mechanisms have been utilized in face masks for removing pathogens and particulates. Due to the belief that many pathogens "hitch a ride" on air borne particulates, mechanical entrapment of particulates contained within the air passing through the face mask was and is of significant interest. This mechanism, however, is not without its limitations. As the need and desire to remove smaller and smaller particulates with an ever increasing higher and higher desired percentage of particulate removal (% efficiency) has grown, it has become

apparent that certain limitations exist with mechanical entrapment type face masks. Generally speaking, for mechanical entrapment to occur, the pores of the filtration media of the face mask must be smaller than the particulates which are to be entrapped. Otherwise, the particulates will merely pass through the filter resulting in an undesirable low filtration efficiency. Unfortunately, as the pore size of the face mask filtration media is reduced, the ability of the gaseous fluid (air) to pass through the face mask is, likewise, reduced. An undesirable side effect is a concomitant reduction in the amount of gaseous material which can pass through the face mask filtration media in a given period of time. Further, this situation results in the creation of a significant pressure drop (differential pressure) between the two sides of the face mask making it difficult for the wearer to easily breathe through the mask.

In response to the limitations placed upon the abilities of the filtration media of face masks to remove very small particulates, those of skill in the art turned to other m chanisms of particulate removal. One highly satisfactory method was to form the filtration media from a dielectric material. That is, a material which can retain a charge for an extended period of time. The dielectric material of the filter was then subjected to charging as, for example by conventional electreting processes. Exemplary of these processes is a method which applies a charge as a result of the material being subject d to a DC corona discharge treatment. Because the filtration media maintains a charge, it will attract very fine particles having an opposite electrical charge. Further, because the mass of these very fine particulates is so small, the attractive charge is sufficient to retain, that is filter out, the very fine particulates from air passing through the filter media of the face mask. Using a charged dielectric material for the filtration media in face masks, allowed those of skill in the art to contemplate a range of new possibilities. For example, the pores of the face mask filtration media could be maintained at the smallest possible size for mechanical entrapment and even smaller particulates would be removed as a result of the charge. Alternatively, the pores of the filtration media could be enlarged to reduced the pressure drop (pressure differential) between the two sides of th face mask. In such situations filtration efficiencies comparable to face masks having smaller pores could be achieved as a result of the additional filtration efficiency of the charged dielectric material. However, is spite of these significant improvements, face masks having very high bacterial filtration efficiencies, very good breathability as videnced by a low differential pressure for air passing through the face mask coupled with a high degree on comfort as evidenced by the masks's ability to remove perspiration forming between it and the face of the wearer are still highly desirable.

For this reason, those of skill in the art continue to seek improved designs which allow enhanced breathability as evidenced, for example, by a low differential pressure for air passing through the mask while still maintaining superior comfort and wearability.

OBJECTS OF THE INVENTION

Accordingly, it is a general object of the present invention is to provide a face mask which possesses enhanced ability to remove pathogens from air passing therethrough.

Another object of the present invention to is provide a face mask which possesses enhanced ability to remove particulates from air passing therethrough.

Yet another object of the present invention is to provide a face mask which, provides superior wearability and comfort by having the ability to remove perspiration forming between it and the face of the wearer.

Still further objects and the broad scope of applicability of the present invention will become apparent to those of skill in the art from the details given hereinafter. However, it should be understood that the detailed description of the presently preferred embodiment of the present invention is given only by way of illustration because various changes and modifications well within the spirit and scope of the invention will becom apparent to those of skill in the art in view of the following description.

DEFINITIONS

As used herein, the term "dielectric material" refers to any material, such as a polymer, which is an electrical insulator or in which an electric field can be sustained with a minimum dissipation of power. A solid material is a dielectric if its valence band is full and is separated from the conduction band by at least 3 eve. This definition is adopted from the McGraw-Hill Encyclopedia of Science & Technology, Third Edition, Copyright 1992.

As used herein, the term "non-dielectric material" refers to any material which is not a dielectric material.

As used herein, the terminology "electret treatment" or "electreting" refers to any process which places a charge in and/or on a dielectric material such as a polyolefin. The charge typically includes layers of positive or negative charges trapped at or near the surface of the polymer, or charge clouds stored in the bulk of the polymer. The charg may also include polarization charges which are frozen in alignment of the dipoles of the molecules. Methods of subjecting a material to electreting are well known by thos skilled in the art. These methods include, for example, thermal, liquid-contact, electron beam and corona discharge methods. One exemplary process for placing a charge on a dielectric material involves the application of a DC corona discharge to the material. An

x mplary conventional method of this type is described in detail in U.S. patent number 5,401,446 to Tsar et al. entitled "Method and Apparatus for the Electrostatic Charging of a W b or Film" which issued on March 28, 1995. The entirety of this patent is hereby incorporated herein by reference. This technique involves subjecting a material to a pair of electrical fields wherein the electrical fields have opposite polarities.

As used herein the term "conjugate fibers" refers to fibers which have be n formed from at least two polymers spun together to form one fiber. The polymers are usually different from each other though conjugate fibers may be monocomponent fibers. Conjugate fibers are also sometimes referred to as multicomponent fibers. Conjugate fibers having only two different polymers are generally referred to as bicomponent fib rs. The polymers are arranged in substantially constantly positioned distinct zones across the cross-section of the conjugate fibers and extend continuously along the length of the conjugate fibers. The configuration of such a conjugate fiber may be, for exampl , a sh ath/core arrangement wherein one polymer is surrounded by another or may be a sid by side arrangement, a pie arrangement or an "islands-in-the-sea" arrangement. Conjugate fibers are taught in US Patent 5,108,820 to Kaneko et al., US Pat nt 4,795,668 to Krueger et al. and US Patent 5,336,552 to Strack et al. Conjugate fibers ar also taught in US Patent 5,382,400 to Pike et al. and may be used to produce crimp in the fibers by using the differential rates of expansion and contraction of the two (or more) polymers. Crimped fibers may also be produced by mechanical means and by th process of German Patent DT 25 13 251 A1. For two component fibers, the polymers may be present in ratios of 75/25, 50/50, 25/75 or any other desired ratios. The fib rs may also have shapes such as those described in US Patents 5,277,976 to Hogle et al., US Patent 5,466,410 to Hills and 5,069,970 and 5,057,368 to Largman et al., which describe fibers with unconventional shapes.

As used herein, the term "nonwoven web" refers to a web that has a structure of individual fibers or filaments which are randomly interlaid, but not in an identifiable, rep ating pattern. Nonwoven fabrics can be made from a variety of processes including, but not limited to, air laid processes such as, for example, meltblowing processes, spunbonding processes, wet-laid processes, hydroentangling processes, staple fiber carding and bonding, and solution spinning. Suitable nonwoven fabrics include, but are not limited to, spunbonded fabrics, meltblown fabrics, wet-laid fabrics and combinations thereof.

As used herein, the term "spunbonded fibers" refers to a web of small diameter fibers and/or filaments which are formed by extruding a molten thermoplastic material, or coextruding more than one molten thermoplastic material, as filaments from a plurality of fine, usually circular, capillaries in a spinnerette with the diameter of the extruded filaments then being rapidly reduced, for example, by non-eductive or eductive fluid-

drawing or oth r well known spunbonding mechanisms. The production of spunbonded nonwoven webs is illustrated in patents such as Appel, t al., U.S. Pat. No. 4,340,563; Dorschner et al., U.S. Pat. No. 3,692,618; Kinney, U.S. Pat. Nos. 3,338,992 and 3,341,394; Levy, U.S. Pat. No. 3,276,944; Peterson, U.S. Pat. No. 3,502,538; Hartman, U.S. Pat. No. 3,502,763; Dobo et al., U.S. Pat No. 3,542,615; and Harmon, Canadian Patent No. 803,714.

As used herein, the term "meltblown fibers" refers to a fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into a high velocity gas (e.g. air) stream which attenuates the filaments of molten thermoplastic material to reduce their diameters, which may be to microfiber diameter. Thereafter, the meltblown fibers are carried by the high-velocity gas stream and are deposited on a collecting surface to form a web of randomly disbursed meltblown fibers. The meltblowning process is well-known and is described in various patents and publications, including NRL Report 4364, "Manufacture of Super-Fine Organic Fibers" by V.A. Wendt, E. L. Boone, and C. D. Fluharty; NRL Report 5265, "An Improved device for the Formation of Super-Fine Thermoplastic Fibers" by K. D. Lawrence, R. T. Lukas, and J. A. Young; and U.S. Pat. No. 3,849,241 issued Nov. 19, 1974, to Buntin, et al.

As used herein, the term "microfibers" means small diameter fibers having an average diameter not greater than about 100 microns, for example, having a diameter f from about 0.5 microns to about 50 microns. More specifically microfibers may also have an average diameter of from about 1 micron to about 20 microns. Microfibers having an average diameter of about 3 microns or less are commonly referred to as ultra-fine microfibers.

As used herein, the term "wet-laid web" refers to fabrics formed by a process, such as a paper-making process, wherein fibers dispersed in a liquid medium are deposited onto a screen such that the liquid medium flows through the screen, leaving a fabric on the surface of the screen. Fiber bonding agents may be applied to the fibers in the liquid medium or after being deposited onto the screen. Wet-laid fabrics may contain natural and/or synthetic fibers.

As used herein, any given range is intended to include any and all lesser included ranges. For example, a range of from 45-90 would also include 50-90; 45-30; 46-89 and th like.

TEST METHODS

BACTERIAL FILTRATION EFFICIENCY (BFE) TEST

This test procedure determines the bacterial filtration efficiency (BFE) of a filtration material by determining the ratio of the bacterial challenge (pre-filtration) counts to effluent (post-filtration) counts to determine percent bacterial filtration efficiency (%BFE).

Cultures of *Staphylococcus aureus* are diluted in 1.5% peptone water to yield challenge level counts of 2200 (+/-500) colony forming units (CFU) per test sample. Th bacterial culture suspension is then pumped through a Chicago nebulizer at a controll d flow rate and constant air to form aerosol droplets with a mean particle size (MPS) of approximately 3.0 microns (m). The aerosol droplets are generated in a glass aerosol chamber and drawn through a six-stage, viable particle, Andersen sampler for collection. The collection flow rate through the test sample and Andersen sampler is maintained at 28.3 liters per minute (LPM) (1 cubic foot per minute (CFM)). Test controls and test samples are challenged for a two minute interval. The delivery rate of the challenge is designed to produce a consistent challenge level of 2200 +/- 500 CFU on the test control plates. A test control (no filter medium in the airstream) and a reference material are included after every 7-10 test samples. The reference material must be within the upper and lower control limits (3 standard deviations) established for the test. An Andersen sampler, a sieve sampler, is designed to impinge the aerosol droplets onto six (6) agar plates based on the size of each droplet. The agar medium used is soyb an casein digest agar (SCDA). The agar plates are incubated at 37 degrees Centigrade (C.) +/- 2 degrees C. for 48 +/-3 hours. Thereafter, the colonies formed by each bacteria laden aerosol droplet are counted and converted to probable hit values using the hole conversion chart provided by Andersen. These converted counts are used to determine the average challenge level delivered to the test sample. The distribution ratio of colonies for each of the six agar plates are used to calculate the mean particle size (MPS) of the challenge aerosol.

Filtration efficiencies are calculated as a percent difference between test sample runs and the control average using the following equation:

$$\text{BFE \%} = \frac{C-T}{C} \times 100$$

Where: C = Average of control values.

T = Count total for test material.

Th purpos of this procedure is to consistently m asure, as accurately as possibl , th differences between materials, or differences in th same mat rial over time. Lastly, the r sults are statistically analyzed to det rmin wh ther any unusual variations exist which may indicate a need for retesting to confirm that the results are, indeed, correct.

DIFFERENTIAL PRESSURE (Delta P) TEST

The Differential Pressure (Delta P) test determines the air exchange differential of porous materials.

The Differential Pressure or Delta P test measures the differential air pressure on either side of the test sample using an incline or U tube manometer. Air flow through th t st sample is maintained at 8 liters per minute (LPM). The Delta P values are reported in millimeters of water per square centimeter of test area and calculated using th following equation:

DELTA P = M/TEST AREA

Where: M = Average millimeters of water per square centimeter of test area of all determinations for each sample.

Note that the sample holder used in the Delta P test should have a test area of 5.06 square centimeters.

At least one reference material is included with each set of test samples. The differential pressure values for the reference material are also recorded and must be within the upper and lower control limits (3 standard deviations) for the test.

WETTABILITY TEST

The wettability test is designed to demonstrate a material's ability to absorb a fluid such as perspiration.

A 4 inch by 4 inch one-ply sample of the material is placed upon a planar non-absorbing surface such as a metal anvil. A drop of water is applied to the surface of the

material to be t sted and the time necessary for the drop to be absorbed into the material as viewed by the unaided eye is measur d.

SUMMARY OF THE INVENTION

In response to the foregoing challenges which have been experienced by those of skill in the art of face mask design, an improved face mask for removing particulates and pathogens from air passing therethrough has been invented. In particular, the face mask includes a layer of electret treated crimped conjugate fibers and an innermost, wettable layer which possesses enhanced wearability and comfort as evidenced by its ability to absorb a drop of water within from about 10 to about 30 seconds. In particular, the face mask has a bacterial filtration efficiency of at least 99% and a differential pressure of less than 4.0 mm H_2O/cm^2.

In some desirable embodiments, the crimped conjugate fibers are spunbonded fib rs. More particularly, the crimped conjugate fibers may be bicomponent fibers. If the crimped conjugate fibers are bicomponent fibers, they may be side-by-side fibers or eccentric sheath-core fibers.

Typically, the layer of crimped conjugate fibers has a basis weight of from 0.5 ounce per square yard to 3 ounces per square yard. More particularly, the lay r of crimped conjugate fibers has a basis weight of from 1 ounce per square yard to 2.5 ounces per square yard. Even more particularly, the layer of crimped conjugate fibers may have a basis weight of about 2 ounces per square yard.

In some embodiments the face mask has a bacterial filtration efficiency of at least 99.5%, a differential pressure of less than 2 mm H_2O/cm^2, or both. The face mask may have a differential pressure of less than 1 mm H_2O/cm^2.

Desirably, at least one of the polymer components of the crimped conjugate fibers is a polyolefin. In some embodiments, both polymer components may be a polyolefin. More particularly, the polymer components may be selected from the group including polyethylenes and polypropylenes.

In some embodiments, the electret treatment of the crimped conjugate fibers is effected by application of a DC corona discharge treatment to the crimped conjugate fibers.

In some embodiments, the innermost wettable layer may have the ability to absorb a drop of water in from about 10 seconds to about 20 seconds. More particularly, the innermost wettable layer may have the ability to absorb a drop of water in from about 10 seconds to about 15 seconds.

Th innermost wettable layer may be selected from the group including ~~a~~ surfactant treated wet-laid web and a surfactant treated layer of spunbonded fibers. Where the innermost layer is a wet-laid web, the wet-laid web desirably may include or be completely formed from cellulosic (wood) fibers. Where the innermost layer is a layer of spunbond fibers, the spunbond web may include or be completely formed from a polyolefin such as, for example, polyethylenes and polypropylenes. Similarly, th innermost layer may be formed from natural fibers such as cotton, linen, jute, hemp, cotton, wool, wood pulp, regenerated cellulosic fibers such as viscose rayon and cuprammonium rayon; or modified cellulosic fibers, such as cellulose acetate. Blends of n or more of the above fibers may also be used to form the innermost layer, if so desired.

In still further embodiments, the face mask may include an outermost layer. In some of these embodiments, the outermost layer may be a layer of spunbonded fibers. Where the outermost layer is a layer of spunbond fibers, the fibers are desirably formed, in whole or part, from polyolefins such as, for example, polyethylenes and polypropylenes.

In other embodiments, the outermost layer may be a wet-laid web. Where the outermost layer is a wet-laid web, the wet-laid web desirably may include or b completely formed from cellulosic (wood) fibers.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view of one embodiment of the present invention.

Figure 2 is a side view of the embodiment illustrated in Figure 1, with the face mask being worn.

Figure 3 is a cross sectional view of the filtration section of the face mask of Figure 1.

DETAILED DESCRIPTION OF THE INVENTION

Turning now to the drawings where like reference numerals represent lik or quivalent structure or process steps, Fig. 1 is a side view of one embodiment of the face mask of the present invention. Figure 1 illustrates that the face mask 10 includes a flexible porous filtering section 12 which, itself, includes a plurality of distinct rectangular layers. A head strap 14 is carried by the upper corners 16 of the mask 10 while the lower

edge 18 of the face mask 10 is folded to provide a pouch 20 which is adapted to engage the chin of a w arer as is illustrated in Figure 2.

The filtration section 12 of the face mask 10 is formed from a lay r 22 (Best seen in Figure 3.) of electret treated crimped conjugate fibers.

Conjugate fibers suitable for the present invention may have at least one or all of th ir polymer components selected from the wide variety of thermoplastic polymers that are known to form fibers. Suitable polymers include, but are not limited to, polyolefins, e.g., polyethylene, polypropylene, polybutylene, and the like; polyamides, e.g., nylon 6, nylon 6/6, nylon 10, nylon 12 and the like; polyesters, e.g., polyethylene terphthalate, polybutylene terphthalate and the like; polycarbonates; polystyrenes; thermoplastic lastomers, e.g., ethylenepropylene rubbers, styrenic block copolymers, copolyester elastomers and polyamide elastomers and the like; fluoropolymers, e.g., polytetrafluoroethylene and polytrifluorochloroethylene; vinyl polymers, e.g., polyvinyl chloride, polyurethanes; and blends and copolymers thereof. Particularly suitable polymer components are polyolefins, including polyethylene; polypropylene; polybutylene; and copolymers as well as blends thereof. Of the suitable polymers for forming conjugate fibers, particularly suitable polymers for the high melting component of th conjugate fibers include polypropylene, copolymers of polypropylene and ethylene and blends thereof, more particularly polypropylene, and particularly suitable polymers for the low melting component include polyethylenes, more particularly linear low density polyethylene, high density polyethylene and blends thereof; and most particularly suitable component polymers for conjugate fibers are polyethylene and polypropylene.

In some desirable embodiments, the crimped conjugate fibers are spunbonded fibers. More particularly, the crimped conjugate fibers may be bicomponent fibers. If the crimped conjugate fibers are bicomponent fibers, they may be side-by-side fibers or eccentric sheath-core fibers.

Typically, the layer 22 of crimped conjugate fibers has a basis weight of from 0.5 ounce per square yard to 3 ounces per square yard. More particularly, the layer 22 of crimped conjugate fibers has a basis weight of from 1 ounces per square yard to 2.5 ounces per square yard. Even more particularly, the layer 22 of crimped conjugate fibers may have a basis weight of about 2 ounces per square yard. One particularly desirable layer 22 of crimped conjugate fibers may be obtained from the Kimberly-Clark Corporation under the trade designation BREEZE.

The layer 22 of crimped conjugate fibers has been subjected to electreting in order to instill a charge on the fibers of the layer. Electreting may be accomplished by, for xample, application of a DC corona charge (DC corona discharge treatment) in a conventional manner. The method described in U.S. Patent No. 5,401,446 is a conventional method for DC corona discharge treatment. The contents of this patent are

hereby incorporated by reference. One way the DC corona discharge treatment could b effected would b to produce the corona discharge by using a Model No. P/N 25A - 120 volt, 50/60 Hz reversible polarity power unit (Simco Corp., Hatfield, Pennsylvania), connected to a RC-3 Charge Master charge bar (Simco Corp.), and a Model No. P16v 120 volt, 25 A 50/60 Hz power unit (Simco Corp.) connected to a solid, three inch diameter, aluminum roller. The corona discharge environment could be at ambient temperature and at a relative humidity of about 30%. As described in U.S. Patent No. 5,401,446, two sets of charge bars/rollers could be used.

Depending upon processing conditions, the amount of electret charge instilled on the layer of crimped conjugated fibers, and/or the density and basis weight of the layer 22, the resulting layer 22 will have a bacterial filtration efficiency of at least 99%, a differential pressure of less than 4.0 mm H_2O/cm^2 or both. For example, the resulting layer 22 may have a bacterial filtration efficiency of at least 99.5%, a differential pr ssure of less than 2 mm H_2O/cm^2 or both. For example the layer 22 of crimped conjugate fibers may have a differential pressure of less than 1 mm H_2O/cm^2.

The inner surface of the filtration section 12 is provided with an innermost wettable layer 24 (See Figure 3.) which possesses the ability to absorb a drop of water in from abut 10 seconds to about 30 seconds. This range is highly desirable becaus it allows for the rapid removal of perspiration from the portion of a wearer's face while not b ing so strong an absorbant as to create problems for the skin of the wearer such as, for example, desiccation. For example, the innermost layer 24 may have the ability to absorb a drop of water in from about 10 seconds to about 20 seconds. More particularly, th innermost layer 26 may have the ability to absorb a drop of water in from about 10 s conds to about 15 seconds.

The innermost wettable layer 24 may be formed from, for example, a surfactant treated wet-laid web or a surfactant treated layer of spunbonded fibers. Where the innermost layer 24 is a wet-laid web, the wet-laid web desirably may include or b completely formed from cellulosic (wood) fibers. Where the innermost layer 24 is a layer of spunbond fibers, the spunbond web may include or be completely formed from a polyolefin such as, for example, polyethylenes and polypropylenes. Similarly, th innermost layer 24 may be formed from surfactant treated natural fibers such as cotton, linen, jute, hemp, cotton, wool, wood pulp, regenerated cellulosic fibers such as viscose rayon and cuprammonium rayon; or modified cellulosic fibers, such as cellulose acetat . Blends of one or more of the above fibers may also be used to form the innermost lay r, if so desired.

While the surfactant may be any surfactant which has the ability to transform th innermost layer 24 into a wettable layer, the surfactant must be safe for uses which contact humans. Desirably, the surfactant is a 50/50 weight percentage blend of

ethyloxylated hydrogenated castor oil and sorbitan monoleate. Alternatively, the surfactant may be a polysiloxane.

Th layers 22, 24 can be joined to each other by conventional means such as lamination, adhesives, or sewing. That is to say, the filtration section 12 of the face mask 10 will include a layer 22 of electret treated crimped conjugate fibers 24 in facing juxtaposition with the wettable innermost layer 24. In other embodiments the face mask 10 may include an outermost layer 26, an intermediate layer of electret treated crimped conjugate fibers 22, and a wettable, innermost layer 24. This structure is best illustrated in Figure 3. In this embodiment the materials which may be used to form the innermost layer 24 may be selected from the same group of innermost layer 24 materials discuss d above. These layer materials offer significant advantages in the area of wearer comfort because they touch the wearer and have the ability to remove perspiration from between the face of the wearer and the face mask 10.

In some embodiments, the face mask 10 will also include an outermost layer 26. (Not illustrated.) In other words, the outermost layer 26 and the innermost layer 24 will sandwich the layer 22 of electret treated crimped conjugate fibers. Like the innermost layer 24, the outermost layer 26 may also be a layer of spunbonded fibers. In yet other embodiments the outermost layer 26 may be a wet-laid web. For example, the outermost layer 26 may be a wet-laid web of cellulosic fibers such as pulp fibers.

The face mask 10 of the present invention may be manufactured by any method of making face masks 10 known to those of ordinary skill in the art. For example, th face masks 10 of the present invention may be made by the following process, or a variation thereof. The preformed layers 22, 24 of the face mask 10 are cut to a desired shape and dimensions. The layers 22, 24 are joined together, in conventional manner, to form the filtration section 12. Desirably, the layers 22, 24 may be joined along a peripheral edge of the filtration section 12 so that breathability of the face mask is not compromised. The layers 22, 24 may be joined together by any known attachment means, such as sewing, adhesives, ultrasonic bonding, etc.

The filtration section 12 of the face mask 10, has an upper edge or edg portion, a lower edge or edge portion, and two opposed sides or side edge portions. The filtration section 12 of the mask 10 may also be provided with several folds or pleats, desirably from 1 to 5 pleats, arranged substantially parallel to the upper edge of the generally rectangular body portion. Additionally, the mask 10 may be folded to form horizontal pleats, which unfold when slipped over the face of the wearer to provide sufficient room and adapt to the facial features of the wearer. Alternatively, the mask 10 may contain vertical pleats, arranged substantially parallel to the two opposed edges of the generally rectangular body portion.

In most embodim nts, the layers 22, 24 of the filtration section 12 will be laminated to one another such that th re will be littl t ndency to separat or tear, particularly at th edges of the filtration s ction 22. In some embodiments, it may be desired to employ at least one binding strip along the bottom and side edge portions or along all of the edge portions of the face mask 10 to reduce any tendency which may xist for the layers to separate or the filtration section 12 to tear. The binding strip may be formed from a strip or strips of material, desirably nonwoven material, folded along their longitudinal axes. The edge portions of the filtration section 12 are then placed within the fold and the binding strip either sewn or adhesively secured to the edge portions.

The upper or top edge portion of the filtration section 12 generally includes a binding strip of the type described immediately above. That is, the binding strip is formed from a strip of nonwoven material which is folded on its longitudinal axis such that the fold receives the top edges of layers 22, 24 which are suitably secured therein, either with adhesive means or by stitching through both outer surfaces of the binding strip and th intermediate layers 22, 24. As an alternative to placing the filtration section 12 within the fold formed in a binding strip, the latter may be secured on one surface of the filtration section by use of adhesive means or sewing the strip to the body portion.

Means for fixing the mask 10 to or retaining the mask 10 on the head of a wearer may be provided by straps 14 at the upper corners of the filtration section 12. The tie straps 14 may be secured directly to the filtration section 12 or to any binding strips which are present. Alternatively, the affixing means may take the form of an oversized length of binding strips which are configured to extend about the head of a wearer and be ti d therebehind. While the focus has been directed to surgical face masks 10, there are many other applications for the face masks 10 of the present invention. Oth r applications include, but are not limited to, laboratory applications, clean room applications, such as semi-conductor manufacture, agriculture applications, mining applications, and environmental applications.

While the invention has been described in detail with respect to specific preferred mbodiments thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing, may readily conceive of alterations to and variations of the preferred embodiments. Such alterations and variations are believed to fall within the scope and spirit of the invention and the appended claims.

WHAT IS CLAIMED IS:

1. A face mask comprising:

a layer of electret treated crimped conjugate fibers; and

a wettable innermost layer adapted to absorb a drop of water in from about 10 to about 30 seconds;

and wherein the mask has a bacterial filtration efficiency of at least 99% and a differential pressure of less than 4.0 mm H_2O/cm^2.

2. The face mask according to claim 1, wherein the crimped conjugate fibers are spunbonded fibers.

3. The face mask according to claim 1, wherein the crimped conjugate fibers ar bicomponent fibers.

4. The face mask according to claim 3, wherein the bicomponent fibers are side-by-side fibers.

5. The face mask according to claim 3, wherein the bicomponent fibers are eccentric sheath-core fibers.

6. The face mask according to claim 1, wherein the layer of crimped conjugate fibers has a basis weight of from 0.5 ounce per square yard to 3 ounces per square yard.

7. The face mask according to claim 1, wherein the layer of crimped conjugate fibers has a basis weight of from 1 ounce per square yard to 2.5 ounces per square yard.

8. The face mask according to claim 1, wherein the layer of crimped conjugate fibers has a basis weight of from 1.5 ounces per square yard to 2 ounces per square yard.

9. The face mask according to claim 1, wherein the mask has a bacterial filtration efficiency of at least 99.5%.

10. Th face mask according to claim 1, wherein the mask has a differential pressure of l ss than 2.0 mm H_2O/cm^2.

11. The face mask according to claim 1, wherein the mask has a differential pressure of l ss than 1.0 mm H_2O/cm^2.

12. The face mask according to claim 1, wherein the conjugate fibers have multiple polymer components and at least one of the polymer components is a polyolefin.

13. The face mask according to claim 12, wherein the polymer components are selected from the group consisting of polyethylene and polypropylene.

14. The face mask according to claim 1, wherein the electret treating is carried out by application of a DC corona discharge treatment to the crimped conjugate fibers.

15. The face mask according to claim 1, wherein the innermost layer is selected from the group consisting of a surfactant treated wet-laid web and a surfactant treated lay r of spunbonded fibers.

16. The face mask according to claim 15, wherein the surfactant is a 50/50 weight p rcentage blend of ethyloxylated hydrogenated castor oil and sorbitan monoleate.

17. The face mask according to claim 15, wherein the surfactant is a polysiloxane.

18. The face mask according to claim 15, wherein the wet-laid web comprises cellulosic fibers.

19. The face mask according to claim 18, wherein the surfactant is a 50/50 weight p rcentage blend of ethyloxylated hydrogenated castor oil and sorbitan monoleate.

20. The face mask according to claim 18, wherein the surfactant is a polysiloxane.

21. The face mask according to claim 1, wherein the innermost wettable layer is adapted to absorb a drop of water in from about 10 to about 20 seconds.

22. The face mask according to claim 1, wherein the innermost wettable layer is adapted to absorb a drop of water in from about 10 seconds to about 15 seconds.

23. A face mask comprising;

an outermost layer;

an intermediate layer of electret treated crimped conjugate fibers; and

a wettable innermost layer adapted to absorb a drop of water in from about 10 to about 30 seconds; and

wherein the mask has a bacterial filtration efficiency of at least 99% and a differential pressure of less than 4.0 mm H_2O/cm^2.

24. The face mask according to claim 23, wherein outermost layer is a layer of spunbonded fibers.

25. The face mask according to claim 23, wherein the outermost layer is a wet-laid web.

26. The face mask according to claim 25, wherein the wet-laid web comprises cellulosic fibers.

27. The face mask according to claim 23, wherein the mask has a bacterial filtration efficiency of at least 99.5%.

28. The face mask according to claim 23, wherein the mask has a differential pressure of less than 2.0 mm H_2O/cm^2.

29. The face mask according to claim 23, wherein the mask has a differential pressure of less than 1.0 mm H_2O/cm^2.

30. The face mask according to claim 23, wherein the innermost wettable layer is adapted to absorb a drop of water in from about 10 to about 20 seconds.

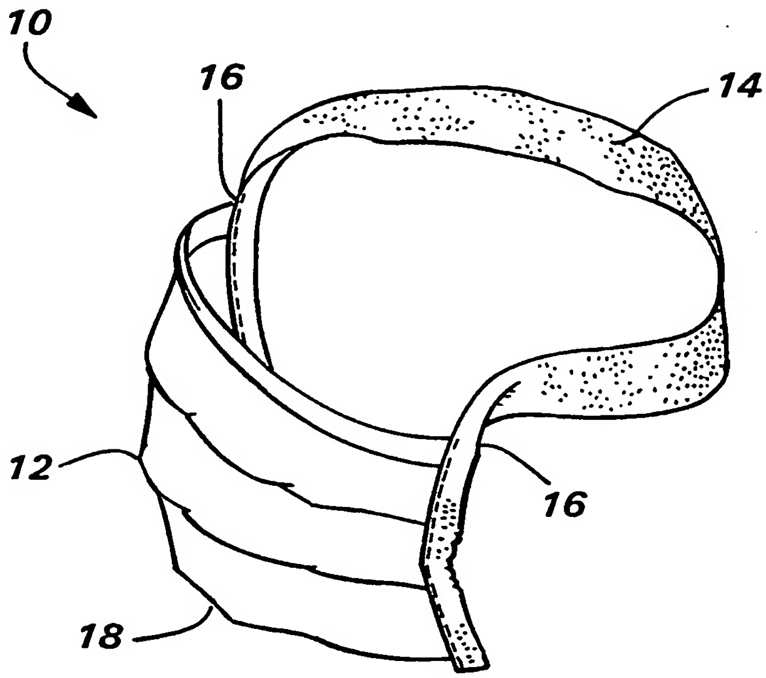
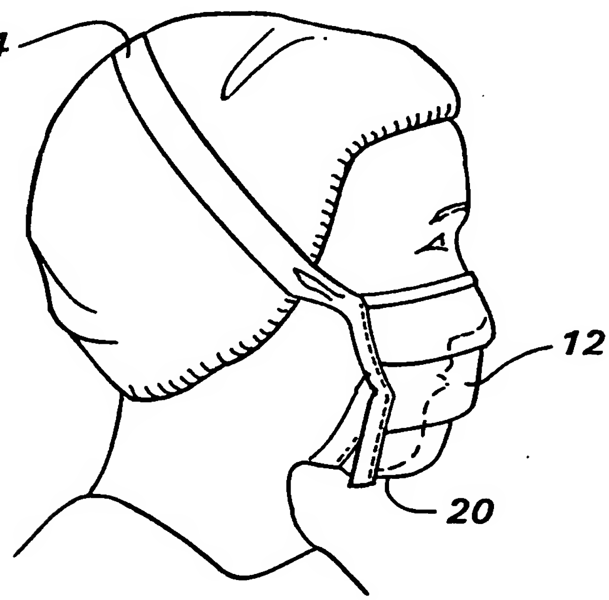


FIG. 1

FIG. 2



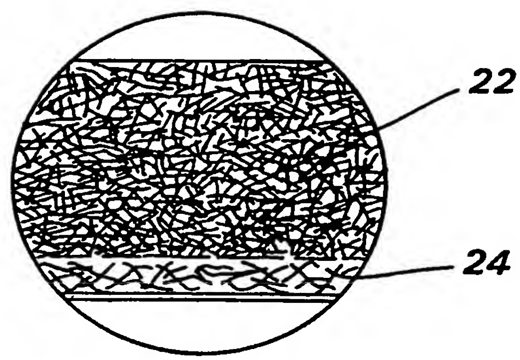


FIG. 3

INTERNATIONAL SEARCH REPORT

Inter. .onal Application No
PCT/[illegible]8/10159

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B01D39/08 A41D13/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B01D A41D B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 391 725 A (JOHNSON & JOHNSON MEDICAL) 10 October 1990 see page 2, line 14 - page 3, line 58 see page 6, line 6 - page 7, line 11; claims 1-12; table 1 ---	1,3,4, 6-15,18, 23,25-29
Y	DE 89 05 261 U (NOWAK) 22 June 1989 see page 1 - page 7 ---	1,23
Y	WO 96 26783 A (HOLLINGSWORTH & VOSE CO) 6 September 1996 see page 1, line 5 - page 3, line 13; claims 1-22; tables 1,2,4,5A,5B,8 --- -/--	3,4, 6-15,18, 25-29

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 September 1998	22/09/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Cubas Alcaraz, J

1

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	WO 95 13856 A (KIMBERLY CLARK CO) 26 May 1995 see the whole document ---	1-30
A	DATABASE WPI Section Ch, Week 9748 Derwent Publications Ltd., London, GB; Class A14, AN 97-524641 XP002077242 & RU 2 079 341 C (DEMINA N M), 20 May 1997 see abstract -----	1,17,20

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/U[illegible]8/10159

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0391725 A	10-10-1990	AT 107494 T	15-07-1994
		AU 5295390 A	11-10-1990
		CA 2014053 A	07-10-1990
		DE 69010051 D	28-07-1994
		ES 2060027 T	16-11-1994
		GR 90100242 A	27-09-1991
		JP 3063046 A	19-03-1991
DE 8905261 U	22-06-1989	DE 8911801 U	28-12-1989
WO 9626783 A	06-09-1996	US 5645627 A	08-07-1997
		AU 4915496 A	18-09-1996
WO 9513856 A	26-05-1995	AU 689167 B	26-03-1998
		AU 1049695 A	06-06-1995
		BR 9408068 A	24-12-1996
		CA 2124389 A	17-05-1995
		CN 1141598 A	29-01-1997
		EP 0729375 A	04-09-1996
		PL 314312 A	02-09-1996